(12) UK Patent Application (19) GB (11) 2 128 549 A

(21) Application No **8229252**
(22) Date of filing **13 Oct 1982**
(43) Application published **2 May 1984**
(51) **INT CL³**
B42D 15/02
(52) Domestic classification
B6A C13 C31 C51 C52 C72 L
(56) Documents cited
GB A 2093404
GB 1390302
(58) Field of search
B6A
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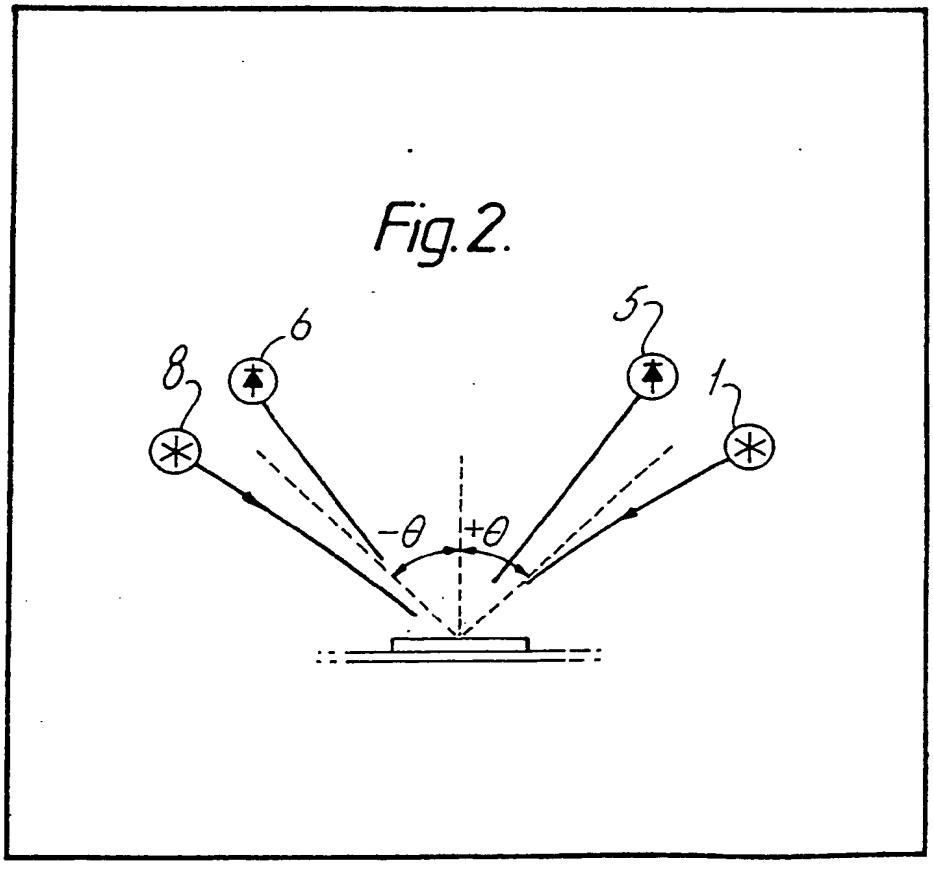
(54) **Debit/credit card**

(57) A document for which a high degree of security is needed, e.g. a debit card, has on it patches of an obliquely-reflective foil material such as aluminium foil with closely spaced angled spinules. This looks dark from one angle and rather silvery from another angle. The value-indicating patches for a credit card each consists of a spot of such material. Various methods of cancellation of the dots are described.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig.1.

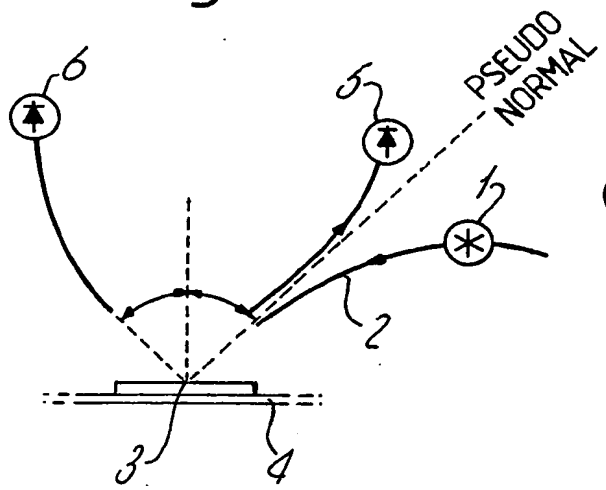


Fig.2.

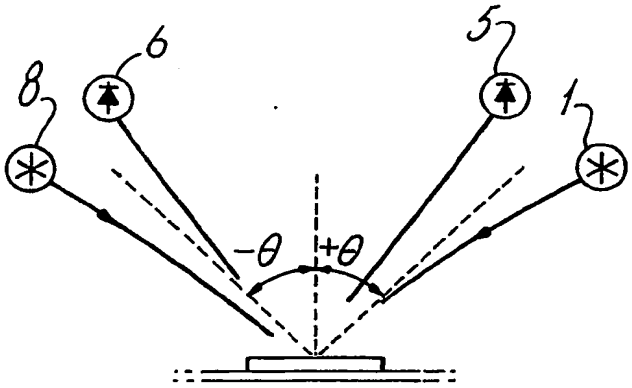


Fig.3.

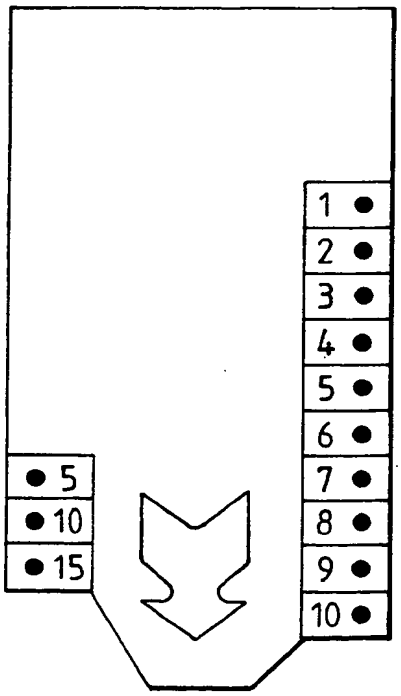


Fig.4.

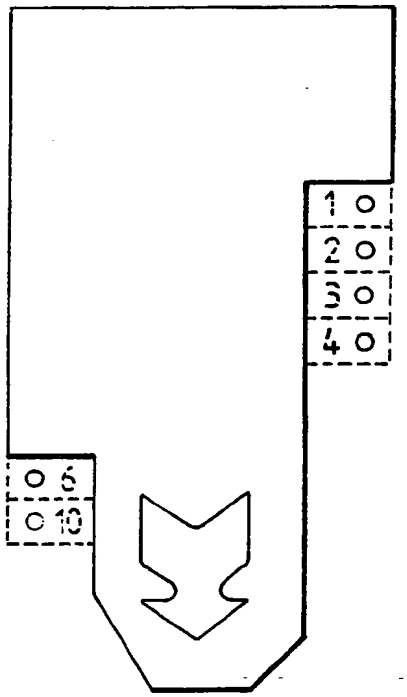
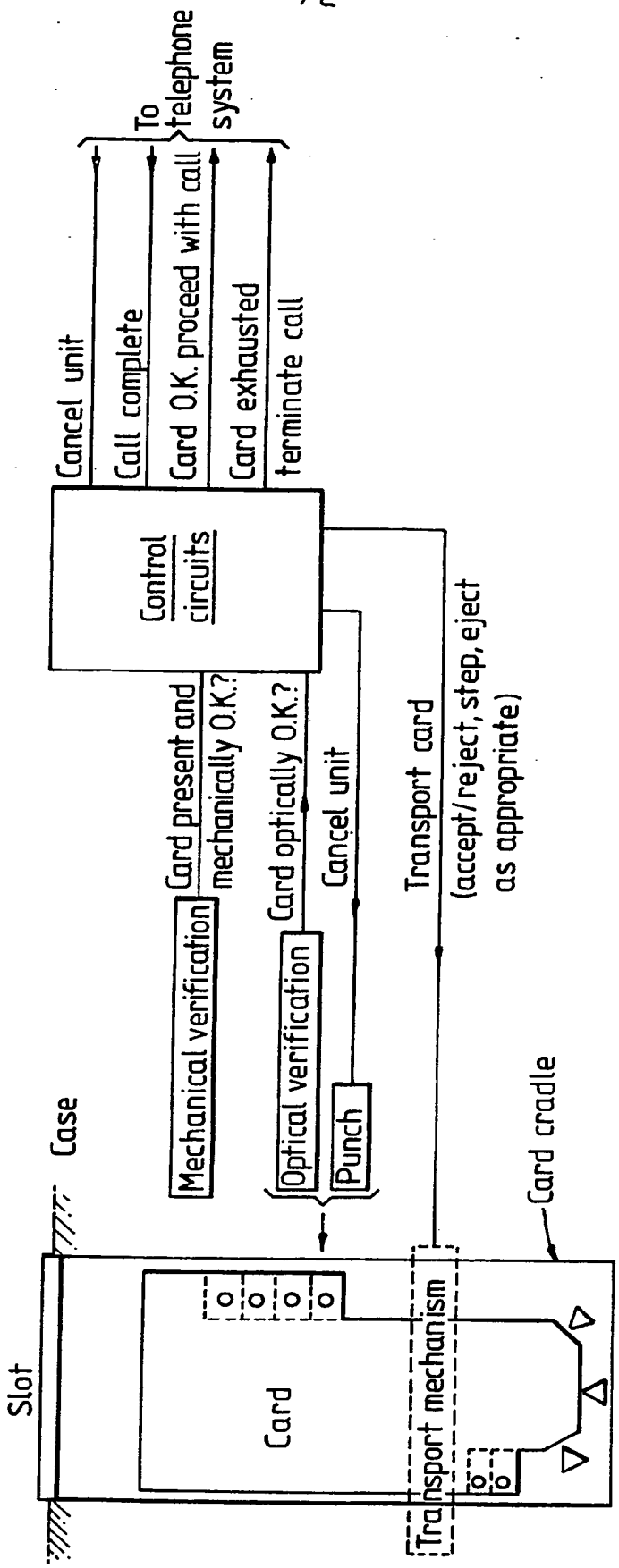


Fig.5.


To telephone system
Cancel unit
Call complete
Card O.K. proceed with call
Card exhausted terminate call
Control circuits
Card present and mechanically O.K.?
Card optically O.K.?
Cancel unit
Transport card (accept/reject, step, eject as appropriate)
Mechanical verification
Optical verification
Punch
Case
Card cradle
Slot
Card
Transport mechanism

SPECIFICATION

Debit/credit card

The present invention relates to documents, such as debit cards and credit cards, for which a high degree of security is needed.

According to the invention there is provided a document for which a high degree of security is needed, which bears one or more patches of an obliquely-reflective material, the validity of the document being assessed by illuminating it with a light beam and viewing it from two different directions, wherein if the document is valid the light reflection characteristics in the two directions differ.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which

Figure 1 is a simplified diagram explaining a document verification method usable with a card embodying the present invention.

Figure 2 is a diagram similar to Figure 1 explaining another document verification method usable with the present invention.

Figure 3 shows a debit card embodying the invention.

Figure 4 shows the debit card of Figure 3 when all credit units are exhausted, with its condition when partly used indicated in broken lines.

Figure 5 is a card reader/canceller usable with cards such as shown in Figures 3 and 4.

The obliquely-reflective material used, which is referred to as oblique foil, is an aluminium foil on the surface of which a dense array of minute columnar "spinules" of aluminium is grown, each spinule leaning at approximately the same angle to the geometrical normal to the foil. This material when viewed optically in some directions looks sooty black and in other directions looks silvery grey. This is somewhat crudely explained on the basis that light incident in directions parallel to the spinules gets lost in the interstices between them, e.g. by multiple reflection from their sides. However, light incident at right angles to the spinules' angle of slant 'sees' an array of tiny reflectors. Thus the optical effect of the foil is rather like an inefficient mirror in the direction normal to the spinules' angle of slant, hence the silvery grey appearance, while in other directions it is almost a non-reflector. The direction normal to the spinules' angle of slant is hereinafter referred to as the material's pseudo-normal.

Although the material at present used is an aluminium foil it is possible to produce such oblique foils from other reflective metals. In fact it is possible to place a homogeneous layer of another metal on top of the columnar structure. Thus a thin layer of copper permits the foil to reflect light even in the critical direction parallel to the spinules. In this direction the foil appears copper-coloured, but at the critical angle it continues to appear silvery. Other colours, e.g. blue and green, can be obtained using such materials as tantalum.

The foils used in the present arrangement can be prepared in the manner described in our Application No. 8025963 (M. P. Drake 11X), which describes the production of foils of, e.g. aluminium. In that application the intended use of the foils is as electrodes for electrolytic capacitors, where the large surface area due to the spinules is valuable. Other aspects of the production of such foils are described in our Application No. 8137227 (M. P. Drake—D. W. Hazeldean 14-7), where the foils are made for certain optical application such as solar absorbers.

The material's optical effects referred to above are immediately evident to the naked eye and can also be readily detected by opto-electronic reading methods. Further a coating of such material can be applied in specific patterns, e.g. via a mask, perhaps involving several spinule angles. Hence the foil could be used as a kind of printing medium with characteristics quite different from any conventional ink, and this property is exploited in the arrangements described herein.

An important property of patterns formed by this material is their security, since patterns with the correct properties would be difficult to replicate, except with relatively complex machinery. The range of such applications is enhanced if the spinules could be grown on a transparent base.

The need for secure printing has long existed, but has intensified recently with the growth of the "cashless society", with its emphasis on documents, e.g. cheques and credit/debit cards, which can be read by both humans and machines. Here fraud is now a growth industry, and a degree of protection is needed which at least equals—and is preferably much better than that built in to bank notes. The classical ways of obtaining document protection, are the use of watermarks or their equivalent, and complex printing and these can be used in combination. Each has its problems when applied to machine-readable documents, but these are eased by the use of oblique foil techniques.

Note that a "watermark" need not necessarily be in the body of the base material and the printed matter on a document can be overlaid by a transparent film containing an optically-readable pattern of the obliquely-reflective material which is difficult to forge. Further, the material can be such that it cannot be removed, say, to alter the inscription, without damaging the surface irrevocably. This is cource requires the spinules to be formed on a transparent or semitransparent base.

In the simplest application of oblique foil mat rial as an equivalent of a watermark, prot ction is given by a patch of the foil securely bonded to the document, e.g. a card. To the eye, this path appears silvery in one direction and black in another. A machine can make the same observation and Figure 1 shows the simplest form of reader. The proferred card enters the card reader which then shines a fine beam of light from

a source 1, guided in this case by optical fibre 2, at the angle of th pseudo normal to the oblique foil path 3 on the document 4. If the associated photocell receives a reflection above a pre-set threshold, the machine accepts the card as genuine. As shown there are two photo-detectors 5 and 6, linked to the material via optical fibres. With the light source 1 as shown, a genuine document receives a signal in detector 1 and no signal in detector 2.

A patch of a scattering material, such as that sold under the Trade Mark Scotchlite, would produce a signal in the detector 1, but forgeries using this material are detectable as the second detector 6, which looks along the direction of the spinules, also receives a light signal. Hence signals in both detectors indicates a forgery. This is because, unlike the genuine material, Scotchlite scatters light in this direction also and is readily detected. A strip of conventional reflector, tin foil, say, mounted on the surface could be equally capable of detection since it would reflect light into detector 6, but none in detector 5. Although a spurious but "machine-deceiving" card might be made by setting strips of conventional reflector at the appropriate angle, this would increase the physical thickness of the card, which is easily detected by the machine.

Such a card is unidirectional, as it will only be accepted when inserted into the reader the correct way round. However, a bidirectional reader can be realised by providing a second light source 8, Figure 2, and doing the above test in each direction. In this case a valid document gives a signal in detector 5 and no signal in detector 6 when tested with source 1 if the spinules of the foil are in the "$+\theta$" direction. When tested with source 6, if the spinules are in the direction "$+\theta$", there is no signal in detector 5, but a signal in detector 6. Thus only a genuine card gives a correct response, whichever way it is inserted. The tests in the two directions must be done separately, since a simultaneous test would give a spurious "correct" result for a document with scattering material.

Additional checks on the authenticity of a document would be to check that reflections outside the expected acceptance angle did not exist, and to check that the reflected light contained a component polarised in the correct direction. This test can be used, since reflection from the brighter angle (pseudo-normal) of the oblique foil causes the light to be polarised in a defined direction on reflection.

Some obliquely reflective material is relatively frail and its surface might be unacceptably damaged by continual handling. However, in such a case the material is covered by a transparent protective layer which does not affect its optical properties to any extent. There may also be circumstances in which the markings must be concealed from the human eye, in which they are read at infra red, th protective coating then being an infra red filter which is opaque to the visible.

Security of such methods is high since it can be ensured that material of the correct characteristics is not obtainable on the op n market. It was mentioned above that the original application of the obliquely-reflective material was capacitor electrodes, where its interesting property is its large surface area. Hence care must be taken to ensure that the foil made for that purpose has a radically different angle of slant from the material intended for "watermarking".

Traditionally, security is also obtained by using elaborate visual patterns, e.g. graphics or lettering, printed on the base material, both to establish authenticity and to convey information, e.g. value. The intention is to make their illicit but accurate replication just not worthwhile. Machines normally demand less complex patterns, which are easier to forge, and so rely on other factors, such unusual inks, e.g. magnetic or conductive, which assist reading and also through relative rarity promote security. The same principle can be used with oblique foil by laying the spinules down in human and machine recognisable patterns, especially if the critical directions can be varied in a controllable fashion across the pattern.

This technique can be used to enhance the security of a "watermark", i.e. the machine establishes validity by only checking that the material is present and that it is in the correct places. It can also be used to convey information, like document identity or value, by using simple coding methods, e.g. the Universal Product Code (UPC) or European Article Number (EAN) bar coding systems. It is difficult to "print" such patterns directly, but it is possible to mark them on the surface of a plain piece of material by overprinting in ordinary ink, or mechanically by burning, embossing or punching. Each of these destroys the surface locally, causing the marks to show up against a bright background when correctly illuminated.

The oblique foil principle can be applied to this problem in several ways. In the simplest, a single patch is used as a "watermark" to establish authenticity, as described earlier, but it is also possible to use it as a part of the value coding. Figure 3 shows one possibility, in which each monetary unit is represented by a small patch of the material. When offered the card, the reader, (see Figure 5), first checks that the card was the correct shape and size, that there are sufficient patches on it to pay for the service/article being purchased, and that the patches are of the valid material, as described above. It then supplies the service/article—a telephone call in the example shown—and cancels the appropriate number of patches by destroying or changing the optical properties of their surfaces. This is done by:

(a) punching out the patch;
(b) overprinting with opaque "ink";
(c) crushing th surface locally;
(d) melting the spinules, for example by a heated element brought into contact with the surface, a blast of radiated heat, e.g.

from a laser, or locally applied rf inductiv heating.

Cancellation by any of these means is detectable by eye as well as by machine, giving the human user a readily readable and accurate indication of the current value of a partially depleted card. A radiative cancellation method is particularly attractive, since both this and the preliminary validation can be done outside the body of the reader through a material barrier, such as a glass window. This eliminates the traditional slot, which is always a prine target for the vandal. Infra red reading can be used to assist this process, since the window can be opaque to the visible and thus camouflaged, further discouraging the vandal.

One attractive variation is to assign different values to the spots according to the angle of the spinules. Thus, Figure 4, the fivefold units are differentiated from the single units both by position and by spinule angle. This not only helps the reader, but also discourages fraudulent revalidation: if all angles were the same it might be worthwhile cutting out single units from an unused card and sticking them onto an exhausted card in the "5 unit" position. Further protection, say to limit the use of the card to a given period, can be given by adding an additional machine readable pattern to the card, although it would be advisable to ensure that this was destroyed when the last unit was cancelled. For example, one might make each of the last patches a bar code instead of a simple dot.

Claims

1. A document for which a high degree of security is needed, which bears one or more patches of an obliquely-reflective material, the validity of the document being assessed by illuminating it with a light beam and viewing it from two different directions, wherein if the document is valid the light reflection characteristics in the two directions differ.

2. A debit card on which the value of the card is indicated by one or more unit representing patches of an obliquely-reflective material, the indications appropriate to a said patch being detected by illuminating it with a light beam and viewing it from two different directions, the light reflections caracteristics in the two directions differing for a valid patch.

3. A document as claimed in claim 1, or a debit card as claimed in claim 2, wherein the obliquely-reflective material is a foil of aluminium having a closely spaced network of spinules on one surface, the spinules being at an acute angle to the surface of the foil.

4. A debit card substantially as described with reference to Figures 1 to 4 of the accompanying drawings.

5. Apparatus for the cashless payment for goods or services, which apparatus includes debit cards and a card reader, wherein the value of a said debit card is indicated by one or more value unit-indicating patches of an obliquely-reflective material, each said patch being on the surface of the debit card, wherein when a said card is to b read it is placed in operative relation with the reader which initially checks that the card has at least one valid value indicating patch, wherein the detection and reading of the patches is effected reflectively by detection means, wherein the detection means includes a light source from which a narrow light beam is directed on to a said path from a preset angle, wherein the beam as reflected from a said path is examined from two different directions, the amount of light reflected in said two directions differing by at least a predetermined amount for a valid patch, wherein if at least one valid patch is present the card user is afforded credit and the reader when one or more value units have been used up deletes the patch or patches appropriate to the used-up unit or units, and wherein the deletion of said patch causes a visually detectable change of in the properties of the patch, such that the number of value units remaining available to the card holder is readily detectable.

6. Apparatus as claimed in claim 5, and wherein the obliquely-reflective material is a foil of aluminium having a closely-spaced network of spinules on one surface, the spinules being at an acute angle to the surface of the foil.

7. Apparatus for the cashless payment for goods or services, substantially as described with reference to Figure 5 of the accompanying drawings.

New claims or amendments to claims filed on 23 Dec. 1982.

New claims 8 to 10:—

8. A document for which a high degree of security is needed, which bears one or more patches of an obliquely-reflective material, wherein the obliquely-reflective material is a foil of a highly optically reflective material having a closely-spaced network of spinules on one surface, the spinules being at an acute angle to the foil, wherein the validity of the document is assessed by illuminating it with a light beam and viewing it from two different directions, and wherein if the document is valid the light reflection characteristics in the two directions differ.

9. A debit card on which the value of the card is indicated by one or more unit representing patches of an obliquely-reflective material, wherein the obliquely-reflective material is a foil of a highly optically reflective material having a closely-spaced network of spinules on one surface, the spinules being at an acut angle to the foil, and wherein the indications appropriate to a said patch are d tected by illuminating it with a light beam and viewing it from two different directions, the light reflections characteristics in the two directions differing for a valid patch.

10. A document as claimed in claim 8, or a debit card as claimed in claim 9, wherein the foil is of aluminium.

11. Apparatus for the cashless payment for goods or services, which apparatus includes debit cards and a card reader, wherein th value of a said debit card is indicated by one or more value unit-indicating patches of an obliquely-reflective material, each said patch being on the surface of the debit card, wherein the obliquely-reflective material is a foil of a highly optically reflective material such as aluminium having a closely-spaced network of spinules on one surface, the spinules being at an acute angle to the foil, wherein when a said card is to be read it is placed in operative relation with the reader which initially checks that the card has at least one valid value indicating patch, wherein the detection and reading of the patches is effected reflectively by detection means, wherein the detection means includes a light source from which a narrow light beam is directed on to a said patch from a pres t angle, wherein the beam as reflected from a said patch is examined from two different directions, the amount of light reflected in said two directions differing by at least a predetermined amount for a valid patch, wherein if at least one valid patch is present the card user is afforded credit and the reader when one or more value units have been used up deletes the patch or patches appropriate to the used-up unit or units, and wherein the deletion of said patch causes a visually detectable change in the properties of the patch, such that the number of value units remaining available to the card holder is readily detectable.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1984. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.